



# Initiatives for the Protection of the Swift Creek Reservoir Watershed

## Introduction

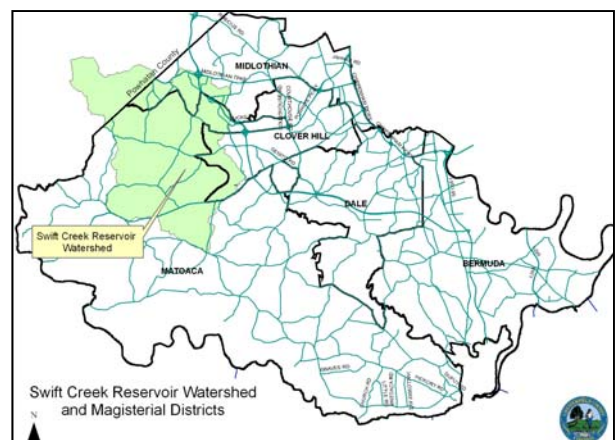
Chesterfield County conducted an assessment of the conditions of the Swift Creek Reservoir Watershed in 1989. Three years later, the Board of Supervisors adopted goals to protect the Swift Creek Reservoir and established a Watershed Management Committee that included citizen and staff representatives. This committee was charged with identifying strategies and alternatives to protect the reservoir. Based on recommendations from the committee in 1997, the Board established through ordinance, a phosphorus loading limit of 0.22 pounds per acre per year (lbs/ac/yr) for new residential development and 0.45 lbs/ac/yr for nonresidential development. These loading limits were established by setting a 0.05 milligrams per liter (mg/L) in-lake phosphorus limit and calculating an allowable annual phosphorus input load. The Board also directed staff to prepare a regional master plan that included a *funding strategy* requiring the development community to fund the construction of regional facilities. Additionally, development within the watershed was to fund the *maintenance* of the regional facilities.

In 2000, the Board unanimously approved the regional master plan called the *Watershed Management Master Plan and Maintenance Program*. The *Watershed Master Plan* was developed to meet the goals and strategies set forth in the Watershed Management Plan of 1996 through the construction of a system of regional stormwater treatment facilities. One of these facilities, the regional in-stream pond component, was to provide the greatest reduction of pollutants.

In January 2006, the use of regional in-stream ponds met with resistance from federal regulatory agencies. During a meeting with the regulatory agencies, staff were advised that the in-stream regional pond component would not receive permitting and any future regional facilities would require off-line construction.

## Description of the Swift Creek Reservoir and its Watershed

The watershed, with portions of three magisterial districts overlaying its boundaries, encompasses 64 square miles or approximately 42,000 acres. The largest area, 85% (35,000 acres) is contained within Chesterfield County with the remaining 15% in Powhatan County. The delineation of the watershed drainage boundaries, which incorporates three comprehensive land-use area plans (see **Appendix A – figure 1**), is important because that boundary defines the portion of the county to be considered when



establishing protection measures for drinking water. The reservoir was constructed in 1966. The 1700 acre impoundment has a 5.0 billion gallon capacity with a plant production capacity of 12 Mgal/day. The watershed is comprised of eight major sub-watershed areas (see **Appendix A - figure 2**). These sub-watershed areas can be used to better target management efforts in order to provide protection to those areas that are most vulnerable to water quality degradation. It should be noted that the closer a stream segment is to the Reservoir, the greater the impact it will have on the water quality of the Reservoir.

## **History of the Programs for the Protection of the Reservoir**

The Departments of Utilities and Environmental Engineering have developed a number of programs, special projects and ordinances intended to achieve specific goals and strategies for the protection of the Swift Creek Reservoir. The following is a synopsis of those activities and programs.

### **I. Watershed Management Committee**

- **1993:** The committee was created by the Board of Supervisors (BOS) to advise and develop goals and strategies for the long-term protection of the Reservoir. The committee members were comprised of county staff, consultants, local experts, environmental groups, citizens, government officials and state agencies.
- **1996:** The committee developed the Watershed Management Plan and voted unanimously to submit it to the BOS for their review and approval. This Plan included:
  - Establishment of a water quality goal of an in-lake phosphorus limit not to exceed 0.05 mg/L.
  - Watershed objective of post-development phosphorus load for new residential development not to exceed 0.22 lbs/ac/yr.
  - Recommendation to develop regional storm water management alternatives to achieve the watershed objective and water quality goal.
- **1997:** The BOS adopted the Watershed Management Plan by amending the Upper Swift Creek Ordinance to include a phosphorus runoff standard of 0.22 lbs/ac/yr. The BOS also directed staff to prepare a Regional Master Plan that included a *funding strategy* which required the development community to fund the construction of regional facilities. Additionally, development within the watershed was to fund the *maintenance* of the regional facilities.
- **1998:** The BOS authorized the contract with the consulting firm of CH2M Hill in conjunction with Timmons Group to develop a Regional BMP Master Plan for the Swift Creek Reservoir Watershed for a cost of \$449,717.

- **1998:** The firms began work on the project in March.
- **1998 – 2000:** Given the complexity of the project and the number of regional facilities, staff and the county's consultants conducted five meetings with the U.S. Army Corps of Engineers (USACE), Virginia Department of Environmental Quality (DEQ) and other environmental agencies that would be reviewing the project. These meetings were conducted *as the Plan was being developed*. During the course of these meetings, staff explained that the overall approach of the Plan was to meet the water quality goals of maintaining phosphorus levels in the Reservoir at or below 0.05 milligrams per liter and to minimize the impact of the regional facilities on wetlands and streams. With such an approach in mind, it was staff's intention to obtain a "master plan" permit for all of the facilities. The permit was approached in this manner because the level of information required for each facility would be far less than if the regional facilities were permitted in phases. During this time staff received positive responses from representatives of those agencies; however staff was given no indication that the master plan approach would not be acceptable to the USACE and DEQ.

During this time staff held meetings to provide briefings on the project to representatives of the engineering and development communities as well as interested citizens' groups.

## II. Watershed Management Master Plan and Maintenance Program

The plan included a permit package that reflected a "master plan" permitting approach, incorporating comprehensive information that included:

- identification of environmental and historic resources
  - identification of technically feasible sites for regional BMP's
  - preliminary design and sizing of the facilities
  - an assessment of the impact of the facilities on streams, wetlands and the Reservoir
  - recommendations for funding the construction of the facilities
  - recommendations for funding the maintenance of the facilities
  - measures to phase in the construction of the basins
- **2000:** The BOS unanimously approved the regional BMP plan called the *Watershed Management Master Plan and Maintenance Program* also referred to as the *Watershed Master Plan*. This plan would allow the county to meet the goals and strategies set forth in Watershed Management Plan of 1996. Objectives of the plan included:
  - achieve the phosphorus loading limits for the Swift Creek Reservoir Watershed

- minimize the environmental impact of development and BMPs
- provide a cost-effective method for capital funding of watershed protection
- minimize long term maintenance costs

The *Watershed Master Plan* recommended the construction of a system of storm water treatment ponds located on perennial and intermittent streams, enhanced floodplains, riparian wetlands, riparian corridor management areas and stream restoration projects (see **Appendix A - figure 3**). All of these facilities are called **Best Management Practices (BMPs)**, which serve to minimize the impacts of development on surface water quantity and quality by removing pollutants from storm water runoff. The goal of the plan is to ensure that pollutants from existing and new development are reduced so that the level of phosphorus in the lake does not exceed a level of 0.05 mg/L. The county's Watershed Management Committee recommended this phosphorus level as a means of minimizing the number and severity of algae blooms to prevent other water quality problems in the reservoir.

The *Watershed Master Plan* included the use of three watershed models to better understand the watershed's characteristics and evaluate the effects of existing and future ultimate land use on hydrology and water quality. The three models used to characterize the watershed are described below:

- **HEC-1:** A hydrologic model developed by the USACE, 1990. HEC-1 was used to model the hydrologic characteristics (hydrographs and flows for different storms) of the watershed. The information received from this model was used for site selection and preliminary design of the regional pond facilities.
- **Urban Catchment Model - P-8:** The watershed pollutant loading model was developed initially for the Narragansett Bay Project (Palmstrom and Walker, 1990). This model was used to simulate the generation and transport of storm water pollutants and to assess the impacts of development on water quality. Simulations are driven by continuous hourly rainfall and daily air temperature time series. Watershed loads based on particle buildup and washoff, modeled separately for pervious and impervious surfaces. The information received from this model is used to determine the pollutant loads, in this case phosphorus, from each of the watershed tributaries.
- **Reckhow Model:** The reservoir water quality model for southeastern reservoirs was developed by K. H. Reckhow (Reckhow, 1989). This model was used to estimate the loads required, under the future planned development, to preserve an in-reservoir total phosphorus limit of 0.05 mg/L, a level considered suitable to control eutrophication in the reservoir. The loads determined with the P-8 model are used to calculate the predicted in-lake phosphorus concentration under different land-use conditions.

In developing the Swift Creek Reservoir regional BMP master plan, staff's goal was to implement a plan that balances the 0.05 mg/l phosphorus limit adopted by the

Board of Supervisors with the protection of other environmental resources such as wetlands and streams. In order to achieve that goal, various tasks were undertaken that are best completed through several different models that perform different functions. The first task involves an assessment on a watershed wide basis, while the subsequent tasks relate to conditions on a subwatershed basis. Subwatershed analyses provide the most accurate means of assessing impacts on streams and other resources.

1) The first, and fundamental, task is to establish the maximum phosphorus load limit, expressed in pounds per year, which will enable the maintenance of the in-lake phosphorus limit. As mentioned above, the Reckhow model utilizing estimated phosphorus loads and flows derived from the P-8 model was used.

2) Next, it is necessary to assess the impact of the increased runoff flows resulting from existing and projected new development on streams and other downstream areas. Note that there is no water quality component of this function. For this task the HEC-1 hydrologic model was used. The resulting information assisted with finalizing BMP locations, designs and sizes in a manner that will reduce the impact of runoff flows on down stream areas.

3) Finally, an evaluation of the pollutant removal performance of the various BMP types was necessary. The scenario selected significantly reduces the wetland impact by reducing the number of wet ponds and using alternative BMPs such as constructed wetlands, enhanced flood plains and riparian corridors. The P-8 model was selected for evaluating the pollutant removal performance of a wide range of BMP types, including the ones selected for this project.

The two models, HEC and P-8, performed functions in addition to those performed by the previous model. While that model predicts expected pollutant loads on a *watershed wide* level well, it does not examine the hydrologic impact of flows resulting from development on streams. Neither does the model permit the evaluation of a variety of BMP's. The HEC-1 and P-8 models perform these tasks.

An Environmental Resource Inventory (ERI) was performed as part of the *Watershed Master Plan* to characterize the environmental resources of the watershed. The environmental resource inventory is a planning tool that is used to identify potential BMPs siting constraints, select appropriate watershed-level BMPs, and support the permitting process.

The *Watershed Master Plan* recommended four funding mechanisms, which were combined into two funding strategies, of which one was a storm water utility program. The strategies could cover the entire cost of the program. After much discussion, additional funding alternatives were brought forward. These alternatives were meant to fund the cost of the construction of the regional facilities, the cost of the maintenance of the regional BMPs and establishment of a county-wide BMP maintenance program. The final funding programs are outlined as follows:

- **Pro Rata Share Program for BMP Construction:** The capital cost for the construction of the regional BMP's would be borne by new development within the watershed.
- **County-wide BMP Maintenance Program:** Funds from the General Fund would be added to the Environmental Engineering budget beginning in FY 2002, to pay for the maintenance of the proposed regional BMP's. Stream restorations projects would be funded from the CIP. These funds would also be supplemented by a one-time fee (\$100 per residential unit) for new construction county-wide.

### III. Implementation of the *Watershed Master Plan*

In order to successfully implement the *Watershed Master Plan*, the development and amendment of county ordinances were required. This effort required a fee structure for the costs of the regional BMPs and establishment of a countywide BMP maintenance program. Additionally, amendments to specific ordinances were required to enforce certain water quality protective measures. Below is a brief description of those ordinances:

- **2001: *Pro-Rata Share Fee*** - The Board of Supervisors adopted an ordinance establishing the pro-rata fee for the construction of the regional BMPs based on storm water runoff as expressed by impervious area.
- **2001: *Residential BMP Maintenance Fee (county-wide)*** - The Board of Supervisors amended the Chesapeake Bay Preservation Ordinance allowing the county to charge a fee of \$100 per residential unit - The fee offsets the cost of the maintenance of new residential BMPs.
- **2001: *Prohibited Activities in Designated Floodplain areas*** - The Board of Supervisors approved an amendment to the existing Floodplain Ordinance adding use restrictions for the protection of certain floodplain areas in the Swift Creek Reservoir Watershed that were designated as BMPs in the plan.

### IV. Permitting Process

Between the time the *Watershed Master Plan* was adopted by the BOS in October, 2000 and the time of permit submittal November, 2002, three major policy changes were made by the regulatory agencies that had a significant effect on staff's permitting approach and the overall design of the plan.

The first policy shift involved a decision by the USACE to reject the concept of a "master plan" permit and instead to request detailed design and wetland impact information for each facility that was to be permitted. Previously, the "master plan" approach had received approval in other localities: for example, Hanover's Lickinghole Creek Regional Plan received USACE approval in 1998. The plan was later renewed in

2002. As will be discussed further below, this change required a significant coordination effort on the part of staff to obtain the detailed information from developers actively seeking approval for development projects in the near future. This caused a delay in finalizing the permit package because of the development projects that had not progressed to the point where detailed designs had been developed.

The second policy change was regulatory in nature and resulted in significant prohibitions on the placement of BMP ponds in both perennial and intermittent streams. Previously, both the USACE and DEQ were generally accepting of ponds in intermittent streams. This is evident from a number of facilities built here in the County and elsewhere. For the location of some of these facilities **see Appendix A - figure 4**. Under the new requirements, ponds will only be permitted in a stream after a rigorous alternative analysis has been performed and if the ponds “serve the public good.” Accordingly, even though staff made a significant effort to seek alternative BMP types that reduced impacts on streams and wetlands, the agencies are now requesting additional analysis of alternatives to reduce those impacts further.

The third policy change was also regulatory in nature and required the mitigation of any stream impacts as a result of development. This includes impacts to stream bottoms from inundation or flooding as a result of the construction of dams for the purpose of storm water treatment, flood control or recreational activities.

The following is a time line showing the progress made on the implementation of the *Watershed Master Plan* to date.

- **2001:** During a formal pre-application conference with a representative of the USACE, county staff and the county’s consultants, we were advised that the agency could not issue a master plan permit. This policy shift required staff to determine which of all of the facilities would be constructed first and to obtain detailed information on the design of the facilities as well as the identified impacts on wetlands and streams. These facilities and impacts would then be part of a “first phase” permit. As development progresses, the permit will then be modified to incorporate additional regional BMP facilities. The selection process for the initial facilities included a review of approved tentative cases, proposed zoning cases, and plans already in the review process. As a result of these reviews, nine regional BMPs were identified to move forward as part of the initial permitting process.
- **2001 – 2002:** Staff worked with the four engineering firms designing those BMPs that were associated with specific development projects to obtain a complete set of detailed plans required by the USACE and DEQ. Detailed information for those facilities not part of development projects were provided by CH2M Hill. The detailed information included such features as maintenance access, structures that draw cool water flows from the BMPs to maintain ambient temperatures in downstream areas (thereby protecting aquatic life), forebays, and safety measures.

- **2002:** A Joint Permit Application (JPA) was submitted to the USACE and DEQ encompassing nine of the regional BMP facilities.
- **2003:** Based on responses from the two regulatory agencies and changes in anticipated development activity, staff revised the permit that was submitted in 2002. Regional BMPs covering two additional development projects were added. Those projects are Charter Colony, which has two regional BMPs on site (LTC-30 and LTC- 20/25) and a new section of Hampton Park (DRY-15). Also included in the application were alternative BMPs such as riparian wetlands which would “mitigate” for impacts of the regional ponds on wetlands and a stream mitigation site located outside the Swift Creek Reservoir Watershed.
- **2005:** Based on additional responses from the regulatory agencies and anticipated development activity, staff again revised the permit to only include those regional BMPs at Charter Colony (LTC-30 and LTC- 20/25) and the alternative riparian wetlands BMP (HPS-55). Additionally, a stream mitigation project was selected within the Pocoshock Creek Watershed. Additional information was submitted to DEQ and the plans were refined as part of their permit review.
- **2005:** DEQ notified the County that they believed due diligence had been conducted with the alternatives analysis and had approved the application but would not issue it, pending Corps actions. The USACE accepted the county’s permit and issued a public notice on November 3, 2005. The public comment period ended December 5, 2005. After this date the county received unofficial comments concerning our permit from the reviewing agencies. The USACE requested a meeting of all parties for the following month in January.
- **2006:** During the January meeting, the regional in-stream BMP pond component of the *Watershed Master Plan* met with resistance from the federal agencies USACE, FWS and EPA. During this meeting staff was asked to address the concerns raised by EPA and USACE in relation to the current permit application. This request required conducting a detail investigation or an alternative analysis of other treatment measures to reduce the need for the in-stream facilities. The report was submitted to the USACE in September 2006. The analysis allowed for the elimination of one of the pond facility. The reduction of one ponds required that the ponds pollutant removal efficiencies be transferred to other alternative BMPs to be located elsewhere within the drainage area of the project.
- **2006:** In February, county administration informed the BOS of the regulatory issues concerning the *Watershed Master Plan*.



- **2006:** Staff completed the alternative analysis as requested by the regulatory agencies as part of the on-going county permit for the regional ponds at Charter Colony. The documents were submitted for review in September. Formal response to the submission has not received. Two regional off-line pond facilities have received USACE and DEQ permits. One of these facilities (WBC-10) is under construction and nearing completion.

## **Modifications to the Watershed Master Plan**

The *Watershed Master Plan* is in its 6th year of implementation. The regional in-stream pond component would have provided the greatest portion of storm water quantity and quality control for the protection of the reservoir. The inability to use this type of treatment, due to regulatory actions from federal agencies, greatly impacts the plan's performance. Staff has identified a framework of tasks and steps needed to modify the plan to meet the regulatory challenges and to provide opportunities to further protect the reservoir. A brief discussion of the progress as well as the needed modifications follows.

- **2006:** As an initial step to address these issues, staff contracted with CH2MHill to develop a *GAP Analysis for the Watershed Master Plan*. The gap analysis identified gaps that may provide opportunities to further protect the Swift Creek Reservoir and to update and refine the *Watershed Master Plan*. The information gained through this document was used by staff to develop framework for the path forward while meeting reservoir protection and Federal Agency regulatory requirements. The work completed as part of this framework is provided below.
- **2006:** During the May CPC work session staff provided an update on the progress made on the *Watershed Master Plan*. As a result of issues raised concerning *Watershed Master Plan* during the July CPC work session on the "Upper Swift Creek Plan" the CPC requested that staff provide monthly status reports during their future work sessions on the progress made on the *Watershed Master Plan*. A brief outline of main topic of discussion follows. Detail information can be found in the staff reports.
  - **August:** Staff developed options and alternatives for the path forward to address regulatory issues and feedback from EPA, USACOE and USFWS concerning *Watershed Master Plan*. The tasks were divided up into three phases, short-term, near-term and long-term. A detail discussion of those tasks to be accomplished to address issues in the Swift Creek Reservoir Watershed was provided.
  - **September:** Discussion of the county ordinances relating to water quality in the Upper Swift Creek Watershed. Set public hearing to discuss proposed amendments.
  - **October:** Public hearing to address the proposed amendment to ordinances relating to water quality in the Upper Swift Creek Watershed.

The Planning Commission recommend approval of the proposed changes to the Board of Supervisors

- **November:** Staff provided a presentation, which addressed work completed with respect to the model calibration, validation and the predicted in lake total phosphorus (TP) median annual value.
  - **November:** Staff provided a presentation to a citizen group, which addressed proposed amendments to ordinances relating to water quality in the Upper Swift Creek Watershed and Tasks and steps needed to address regulatory issues concerning the *Watershed Master Plan*.
  - **December:** Staff was to provide a presentation that addressed work that was completed regarding annual phosphorus load contributions with respect two scenarios. Case 1 considers all zoned parcels. Case 2 considers all of the zoned parcels and their know requirements and proffers. The analysis was still under review and staff was unable to provide the results.
- **2006:** At the December 12, 2006 meeting, the Board held a public hearing to consider the adoption of amendments to the water quality ordinances affecting the Upper Swift Creek Watershed. After hearing from a number of speakers, the Board deferred the public hearing in order to meet with staff to better understand the amendments.
  - **2007:** Staff continued to provide monthly status reports during their future CPC work sessions on the progress made on the *Watershed Master Plan*.
    - **January:** The analysis was still under review and staff was unable to provide the results. However, staff provided a presentation, which addressed additional concerns with respect to the model calibration, validation and provided additional detail on the work being done with respect to the two scenarios.
    - **February:** Due to concerns raised from previous work sessions, CH2M Hill conducted additional analyses cover several independent evaluations of the current model. The analyses demonstrated the relationships between the observed and predicted tributary flow and load data. The results of these analyses and the work done on the two scenarios were provided during the work session.
    - **March:** Staff provided a presentation, similar to that provided to the Board, on the County's initiatives for the protection of the Swift Creek Reservoir Watershed. The presentation discussed a brief history of the program, watershed modeling update and the framework of tasks and steps needed to modify the plan to meet regulatory challenges. Staff continued to work to modify the plan, which will result in the development of future ordinances, policies and practices to protect the water quality of the reservoir.
    - **April:** Staff and the county consultant provided a discussion of the analysis of the watershed model. The results and comparisons conducted

by CH2MHill provide in earlier work sessions were provided as a document for review.

- **2007:** At the February 14, 2007 meeting, the Board continued the public hearing to address the proposed amendment to ordinances relating to water quality in the Upper Swift Creek Watershed. After holding the scheduled public hearing, the Board approved the recommended ordinance amendments.

The modifications can be grouped into three main tasks: 1) the requirement of new construction to address stormwater management on-site, 2) acquire additional detail information on current and future land-use phosphorus contributions and 3) modifications to the *Watershed Master Plan*.

## I. On-site Storm Water Management

On February 14, 2007 the Board amended county ordinances requiring developers to treat stormwater runoff on-site and allow the use of alternative treatment measures to control pollutants if necessary. This effectively removed the requirement of developers to participate in the payment of the regional ponds while still allowing regional facilities to be built off-line when appropriate.

The tasks outlined below are to address on-site storm water management and the issues generated by these changes. The current management program uses regional facilities for storm water treatment; the changes will return the management of storm water to the development. Regional facilities which can be built off-line (not in streams) may still be use, if field conditions provide for this method.

- **County Ordinances:** Adopt amendments to zoning and other ordinances, as necessary, which would require development to treat storm water runoff onsite and/or to implement other remedies.
- **Zoning Cases:** As a condition of any zoning case reviewed by staff, all storm water management will be addressed by the development onsite using approved water quality treatment facilities.

## II. Determine Phosphorus Load Contributions to Reservoir

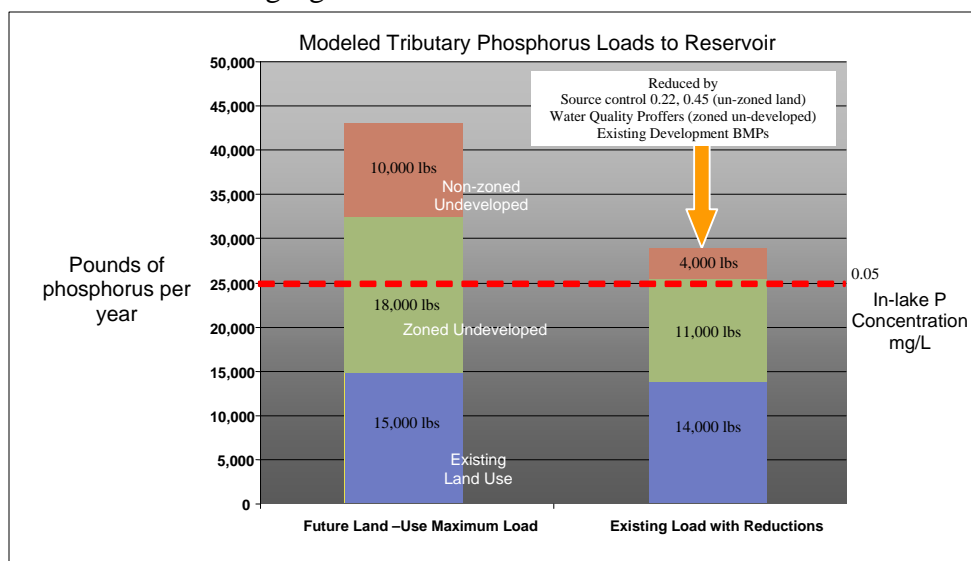
Understanding current and future potential pollutant loads to the reservoir is essential for the development of a successful watershed management program. Staff working in conjunction with consultants revised the existing watershed models to determined phosphorus load contributions to the reservoir as well as predicting in-lake phosphorus concentrations under current and future levels of land-use development. Tasks included:

- **Validation of existing Watershed Models:** compare the model predicted phosphorous loads to data from the County's monitoring programs.

- **Model Current Land-use Loads:** Incorporate current land use information that is based on the 2005 parcel data and provide updated load calculations for phosphorous.
- **Model future Land-use Loads:** Using the 2005 parcel data as a base, determine phosphorus loads involving all parcels that are approved for development but not yet developed.

The comparison of the model loads and concentrations to data from the county's monitoring programs indicated that the model results were within the accuracy of the models. Two additional modeling methods were used as independent verifications of the original modeled results. These modeled results indicated that the results were within the range of predictability and therefore the model results are valid for future pollutant load and concentration predictions (for detail information see CH2MHill TM *Swift Creek Reservoir P8 Modeling Update* April 5, 2007)

Once the results of the models were determined validated, additional modeling was conducted to determine the current and future total phosphorus loads to the reservoir, and the resulting in-lake phosphorus concentration. Based upon the most recent land-use information, staff determined the current or "base" load of phosphorus entering the reservoir. This base load information was then used to predict the anticipated phosphorus associated with future development. The total annual load contribution for existing and future development draining to the reservoir is 43,000 lbs/yr. The loads associated with future development from 1) zoned and undeveloped lands 2) un-zoned property. For demonstration purposes, annual pollutant loads from stormwater runoff have been divided into four land development categories with corresponding loads 1) Existing development = 15,000 lbs/TP/yr 2) zoned undeveloped = 18,000 lbs/TP/yr 3) non-zoned = 10,000 lbs/TP/yr and 4) Powatan's contribution. The results of the work completed are summarized in the following figure:



The required stormwater treatment pollutant load reduction was applied to each of the categories. This reduction was applied as follows:

1. Existing Development – The pollutant treatment efficiency for existing stormwater facilities was applied to reduce the current loads.
2. Zoned Undeveloped - An on-site stormwater treatment reduction of 0.22, 0.30 or 0.45 lbs/ac/yr was applied.
3. Non-zoned - An on-site stormwater treatment reduction of 0.22 lbs/ac/yr was applied.

The regional in-stream pond facilities were intended to reduce this load to a level that met the county's in-lake phosphorus limit of 0.05 mg/L. In the absence of regional in-stream pond facilities the Board, on February 14, 2007 reinstated on-site stormwater controls. The required on-site stormwater load reduction was applied to each of the land use categories. This reduction resulted in annual load contribution exceeding the target load limit by approximately 4000 lbs/yr at ultimate build out under the current and proposed land use plans. The reduction of this load will be required to ensure that the future loads are further reduced to meet the required level of protection to maintain the county's in-lake phosphorus concentration on 0.05 mg/L. The results of the modeling done to date are summarized in the following figure:

	<b>Annual Phosphorus Load in lbs/yr</b>	<b>Calculated In-lake P in mg/L</b>
1999 Existing Land Use	<b>12,000</b>	<b>0.031</b>
2003 Existing Land Use	<b>14,500</b>	<b>0.035</b>
2005 Existing Land Use	<b>15,000</b>	<b>0.035</b>
<b>The most recent land-use layer 2005 was used to determine the base load. The results outlined below incorporate analyses using the base load and the projected loads from future development.</b>		
Zoned Undeveloped	<b>33,000</b>	<b>0.060</b>
Non-zoned Undeveloped Proposed Land Use under County Land Use Plans*	<b>43,000</b>	<b>0.073</b>
<b>Phosphorus load after reduction to meet County in-lake P limit of 0.050 mg/L</b>	<b>25,000 – 26,000</b>	<b>0.050</b>

The Area Plans\* that drain to the reservoir from the County's Land Use Plan were used for the future development loads. (Route 288 Corridor Plan, Midlothian Area Community Plan and the proposed Upper Swift Creek Plan)

### III. Modifications to the Watershed Master Plan

The stormwater site design practices and techniques outlined below identify methods to further limit and reduce pollutant loads from both future and current development. Many of these strategies may be easily incorporated into the *Watershed Master Plan* while others will require additional studies, training and an implementation program.

Stormwater pollution is directly related to the amount of impervious surface within a development. The reason for this is conventional storm water controls use these areas to collect, concentrate and convey stormwater prior to discharge to a waterbody. Reducing impervious surface reduces the amount of runoff and limits the pollutant concentration resulting in the protection of county waters and the reservoir. The following will aid in reducing impervious surface starting with a review of existing county ordinances.

- **County Ordinances (Site Plan and Subdivision):** A preliminary review of county ordinances has identified several ordinances, which could assist in the reduction of pollutant loads from new development. A more comprehensive review of the county's ordinances will be conducted to determine those areas where modifications may help to improve stormwater runoff. The following is a listing of development principles, which would assist in the reduction of water pollution from new development.
  - modified site design
  - modified housing densities and smaller lot sizes
  - modified street widths
  - reduced setbacks and frontages
  - modified parking ratios
  - shared driveways
- **Preservation and Restoration of Natural Cover and Areas:** Retaining the existing natural conditions such as vegetation, soils and wetlands provide a natural and cost effective way to manage stormwater quantity and quality. Watersheds having greater than 35 percent impervious cover tend to negatively impact the aquatic environments. This can be observed by stream bank erosion, reduction in water quality and loss connection with and/or erosion of floodplains. The following are areas where natural conservation can reduce impervious cover.
  - Avoid floodplains and riparian buffer areas
  - Green area set-asides
  - Mature tree preservation
  - Avoidance of steep slopes and highly erodable soils
  - Wetland and Stream Channel protection
- **Lower Impact Site Design Techniques:** LID is a site design strategy with the goal of maintaining or replicating the pre-development hydrologic regime through the use of design techniques to create a functionally equivalent hydrologic landscape. The volume and frequency of stormwater discharges are maintained through integrated and distributed detention and infiltration methods, which use both natural and designed systems.
  - Fit Design to the Terrain
  - Locate Development in less Sensitive Areas
  - Reduce Limits of Clearing and Grading
  - Consider Creative Development Design

- Non-Conventional Storm water Treatment
- Bioretention facilities, where soils permit
- **Utilization of Natural Features for Storm Water Management:** Traditional stormwater systems are designed to collect, concentrate and convey storm flows efficiently away from the development. Natural drainage patterns tend to be ignored and replaced with structural controls. A nontraditional approach would seek to incorporate the sites existing natural features. These could include natural drainage patterns, depressions, permeable soils, wetlands and vegetative areas. This would reduce the number of structural controls and provide for more natural stormwater control of infiltration, pollutant filtration and maximize on-site stormwater storage. Below are examples of some methods, which could be incorporation of as part of the site design practices.
  - Use Buffers and undisturbed Areas
  - Use natural drainageways instead of Storm Sewers
  - Use Vegetative Swale Instead of Curb And Gutter
  - Drain Rooftop runoff to Pervious Areas
- **Alternative Treatment Options:** A feasibility study of the use of a trading program will be conducted. Pollutant trading or credit is an alternative tool for the improving water quality. It provides a business-like way of helping developer's solve water quality problems by focusing on cost effective, local solutions to problems caused by pollution. A program of this nature can take a number of different forms. A few examples of this could be 1) a developer selling the excess pollutant removal efficiency of a stormwater treatment facility, 2) in a more intensively developed sub-watershed, a developer or independent party may provide additional stormwater treatment, thereby reducing the existing loads, providing additional capacity and creating credits for sale, 3) additional credit may be attained by the conservation of existing developable land.
  - Development a Pollutant Trading Program
  - Encourage the Development of Regional Off Line Facilities

The above measures will help to minimize the pollutant loads from future development by controlling the pollutants at the source. That portion of the future loads, which cannot be reduced as part of the on-site treatment and is in excess of the target load limit, is referred to as the 'orphan load'. The reduction of load will need to be addressed through county run projects. The program will be executed through funds collected as part of the pro-rata fees. Many of these projects will be regional in nature and aimed at reducing identified pollutants loads.

- Regional facilities other than in-stream ponds
  - Enhanced Flood plain
  - Riparian Wetlands
  - Stream Restoration and Buffer Enhancements
- Provide treatment for existing phosphorus loads

- Retrofit Existing BMPs (increase flow length)
- Retrofit Existing Lakes
- Develop New BMPs on Existing Developments
- Retrofit culverts and drainage systems, including vegetated open channels
- Compensatory mitigation projects
- Education and incentive programs for existing homeowners to improve stormwater quality on individual lots and open spaces
- Pollutant trading or credit program
- **Commercial Development (reduce pollutant loading):**
  - Manufactured BMPs (non-residential areas only)
  - Address pollutants from “Hot Spots”

## Watershed Master Plan - Financial Summary

**Capital Program:** Pro-rata Share Program for the construction of the regional BMPs as of 12/31/06

### Revenues

Pro-rata Fees	\$1,831,800
General Fund	<u>\$506,400</u>
Total Revenue	\$2,338,200

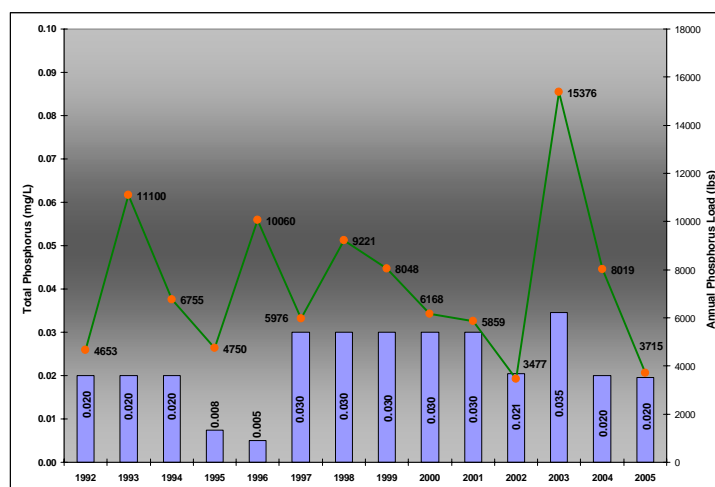
### Expenses

Planning & Design	\$191,401
Permitting	<u>\$811,429</u>
Total Expenses	\$1,002,830

**Balance** **\$1,335,370**

## Proactive Erosion & Sediment Control Requirements

Given the County's concern for the protection of Swift Creek Reservoir as well as the streams leading to the Reservoir, the Environmental Engineering Department has initiated a policy requiring more stringent erosion and sediment control measures for projects proposed in the reservoir watershed. In addition, the two Senior



Growing season (April through October) median total phosphorus concentrations for the main body (Sites 4,5,6 and 8) of Swift Creek Reservoir 1992 – 2005. Measured annual phosphorus loads (pounds/year) from the watershed are depicted on the right side axis.



Construction/Drainage Inspectors whose assigned areas include the watershed have been required to place a high priority on construction sites in that area. It is planned that these measures will reduce the amount of construction site runoff entering the lake. Optic orange fencing is required along the boundaries of sensitive environmental features to provide additional protection of these resources during construction. In addition to the increased on-site requirements, several off-site measures have also been implemented and examples of these additional measures (e.g. turbidity curtains and porta dams) can be seen along the reservoir.

## **Monitoring Programs**

### **Water Quality**

Monitoring on Swift Creek Reservoir and in its watershed has been conducted in various forms and at various sites since the early 1970s. In 1992, a standard core set of reservoir and tributary monitoring stations (**see appendix A - figure 6**), as well as a regimen of analytical parameters was established enabling true comparisons from year to year. Two additional direct run-off monitoring sites, one each in Brandermill and Woodlake were added and operational by 1997 allowing for the collection of information from adjacent developed areas.

This comprehensive monitoring program has been in effect since 1991 and provides general water quality data, quantification of the phosphorus load and determination of the water budget for the reservoir. This data set has allowed for the creation, calibration and verification of ecological models regarding land use in the watershed, as well as providing information critical to the operation of the Addison-Evans Water Production Facility. In 2002, supplemental monitoring was initiated to fulfill State and EPA requirements for the County's Municipal Separate Storm Sewer System (MS4) Permit. This additional effort has gathered information on the biological, chemical and physical characteristics of select streams within the Swift Creek Reservoir Watershed.

General observations since 1992 have demonstrated that phosphorus concentrations and watershed loads are variable. Median growing season total phosphorus concentrations, as measured under current state guidelines, have never exceeded 0.035 mg/L, with measured total phosphorus loads from the watershed ranging from 3,477 to 15,376 pounds/year.

The most recent biological assessments conducted as part of the MS4 permit requirements indicate that the majority of the streams investigated in the Swift Creek Reservoir Watershed are "Slightly Impaired." Habitat assessments since 2002 have demonstrated that the majority of the streams investigated in the Upper Swift Creek Watershed possess either "Partially Supporting" or "Non-Supporting" habitat. Most recent data (2005) indicates elevated phosphorus and nitrogen concentrations at six sites in the Upper Swift Creek Watershed.

## **Education & Outreach Programs**

Preventable non-point source pollution is a major cause of water quality degradation; therefore an informed citizenry is one of most important tools in maintaining and improving water quality. Suburban non-point source pollution includes, but is not limited to, lawn fertilization, pet waste, car washing, illegal dumping into storm drains and poor management of environmental resources. The citizens of the Swift Creek Reservoir Watershed should have a heightened awareness of the watershed in which they live and their personal effects on the reservoir as a drinking water source. The following publications & programs can be tailored for the watershed.

- Water Quality Watch Fact Sheets
  - Series began in 1997
  - 8 topics including RPAs, floodplains and the illicit discharge ordinance
- Brochures
  - Don't Feed the Lake (how lawn care practices affect water bodies)
  - Riparian Buffer Restoration Guidance
  - Pocoshock Creek Community Partnership
- Volunteer Programs
  - Water Quality Monitoring
    - Stream Watchers
    - Lake Monitoring
    - Friends of Chesterfield's Riverfront Chemical Monitoring
  - Events
    - Trash cleanups
    - Riparian Buffer Planting
    - Riparian Buffer Monitoring
    - Storm Drain Marking
    - Citizen Meetings

## **Upper Swift Creek Land-Use Plan**

The following is an outline of the work completed as part of the land-use plan. The initial meeting to discuss amendments to the land use plan was held in March 2003.

- **2003:**
  - **April:** Planning staff met with the county's Water Quality Specialist (WQS) to further discuss the Upper Swift Creek Plan amendment.
  - **July:** Planning staff met with the WQS to discuss the Upper Swift Creek Plan amendment process and time line.
  - **August:** Planning staff met with the WQS to discuss the geography of the area that would be modeled for water quality.
  - **October:** Planning staff met with the WQS to discuss resources and time lines for modeling the Plan.
- **2004:**

- **March:** Planning staff met with the WQS to review the progress of the Plan amendment and the water quality modeling project.
- **April:** Planning staff met with the WQS and water quality consultant to discuss modeling the current Upper Swift Creek Plan for water quality as a baseline for modeling the Upper Swift Creek Plan amendment when drafted. There was general consensus that available model and data are adequate to do the job, and that the current Plan could be modeled by July/August 2004.
- **May:** Planning staff met with the WQS to discuss strategy and time line for Upper Swift Creek Plan amendment.
- **July:** Planning staff received a tentative assessment from the WQS that water quality recommendations for the draft Plan amendment should be ready by 8/12/04.
- **August:** Planning staff attended a workshop hosted by the WQS on Low Impact Development Standards.
- **September:** Planning Department staff completed draft Goals and Recommendations for Planning related issues, together with a draft Land Use Plan recommendation. Further review of the Plan amendment would await input from Transportation and Water Quality.
- **December:** Planning staff met with the WQS to review preliminary results of a partial water quality modeling (existing land use within the Upper Swift Creek Plan amendment geography). Additional time would be needed to model the current adopted Plan and potential Plan amendment scenarios. Water quality recommendations for the draft Plan amendment would have to wait until the modeling is completed and the results are analyzed.
- **December:** The County's WQS provided additional information on preliminary results of the partial water quality modeling.
- **2005:**
  - **January:** Planning staff met with the WQS to review potential land use scenarios that could be modeled by the county's water quality modeling consultant. It was estimated that the results of the modeling should be ready by the end of March.
  - **January:** The County's WQS briefed Planning staff on potential water quality recommendations.
  - **March:** The County's WQS reported that preliminary water quality modeling results had been received, that calculations for sediment loading were forthcoming, and that work on draft recommendations were in progress.
  - **March:** Planning staff provided the County's WQS with additional requested information.
  - **March:** Planning staff provided the County's WQS with additional requested information.
  - **March:** Planning staff met with the County's WQS to review preliminary results of the water quality modeling for the Plan

amendment. The WQS indicated that further analysis would be required before recommendations could be made.

- **April:** Planning staff met with the County's WQS and modeling consultant to review preliminary results of water quality modeling. The WQS indicated that further analysis would be required before recommendations could be made.
- **May:** Planning staff met with the county's WQS to discuss water quality recommendations.
- **May:** The County's WQS provided Planning staff with recommendations for the Upper Swift Creek Plan amendment.
- **June:** Planning staff met with the county's new Water Quality Specialist to discuss water quality recommendations
- **June:** The County's WQS provided Planning staff revised recommendations for the Upper Swift Creek Plan amendment.
- **August:** Planning staff met with the county's new WQS to discuss water quality recommendations.
- **August:** The draft Upper Swift Creek Plan amendment and supporting documentation were forwarded to the Planning Commission.
- **September:** The first work session was held September 20, 2005. The CPC expressed a number of concerns over the Water Quality portion of the plan some of the concerns related to content, model validation/calibration, regional BMPs and Powhatan pollutant contribution.
- **November:** To address the water quality concerns, staff contracted with a consultant.
- **December:** The County received unofficial comments concerning our permit relating to the *Watershed Master Plan* from the reviewing agencies. The USACE requested a meeting of all parties for the following month in January (see page 8 for a detail discussion).
- **2006:**
  - **July:** The County's WQS provided Planning staff revised recommendations for the Upper Swift Creek Plan amendment.
- **2007:**
  - **May:** The Planning Commission held a public meeting on May 3, 2007, to discuss the Upper Swift Creek Plan. Mr. Gulley requested that Environmental Engineering provide the Commission with a detail chronological record of the county's interaction with state and federal agencies regarding efforts to address water quality issues within the Upper Swift Creek watershed. Mr. Gully further requested that Environmental Engineering provide the Commission with a detail chronological record on the progress of the Environmental Quality portion of the draft Upper Swift Creek Plan amendment, from the beginning of the Plan amendment process to the present.

Figure 1.

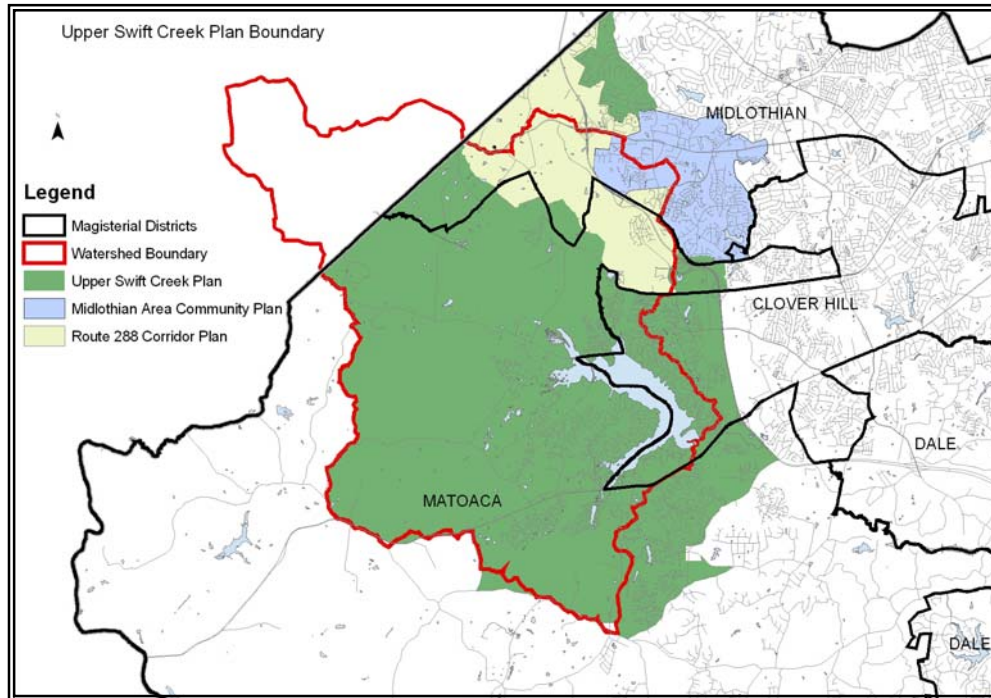


Figure 2.

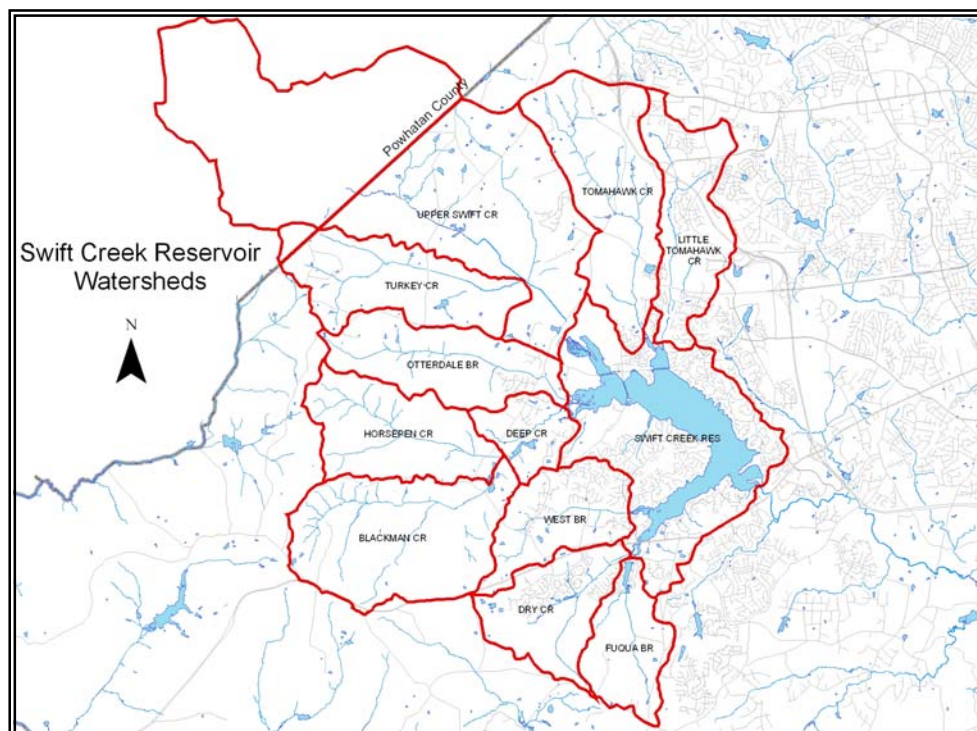




Figure 3.

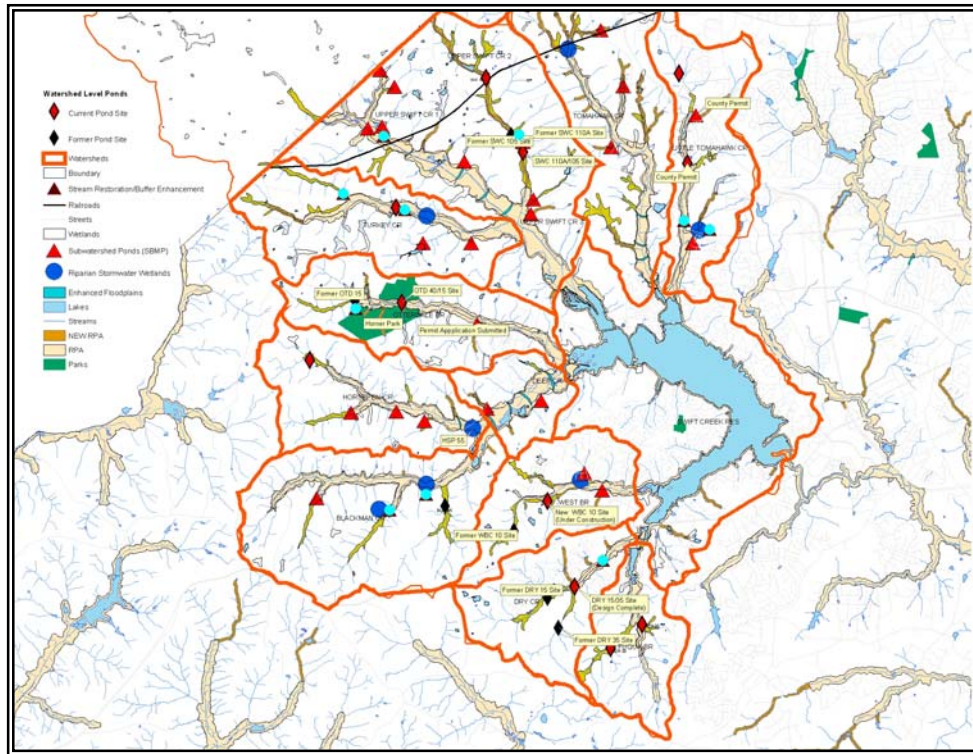


Figure 4.

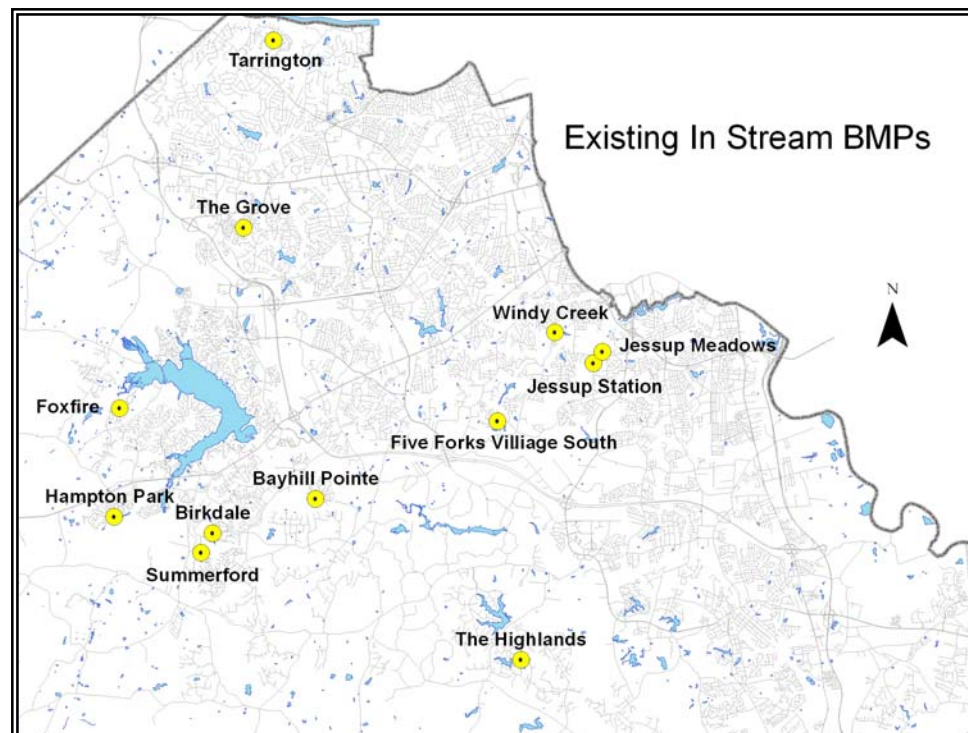


Figure 5.

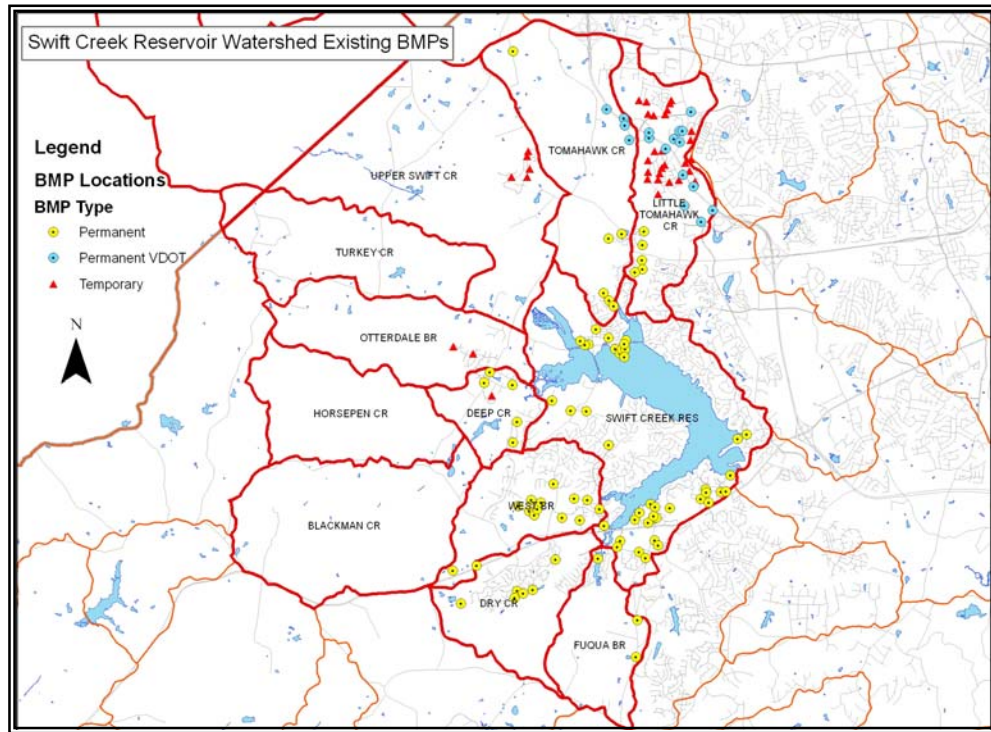


Figure 6.

